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Lubrication

A Technical Publication Devoted to
the Selection and Use of Lubricants

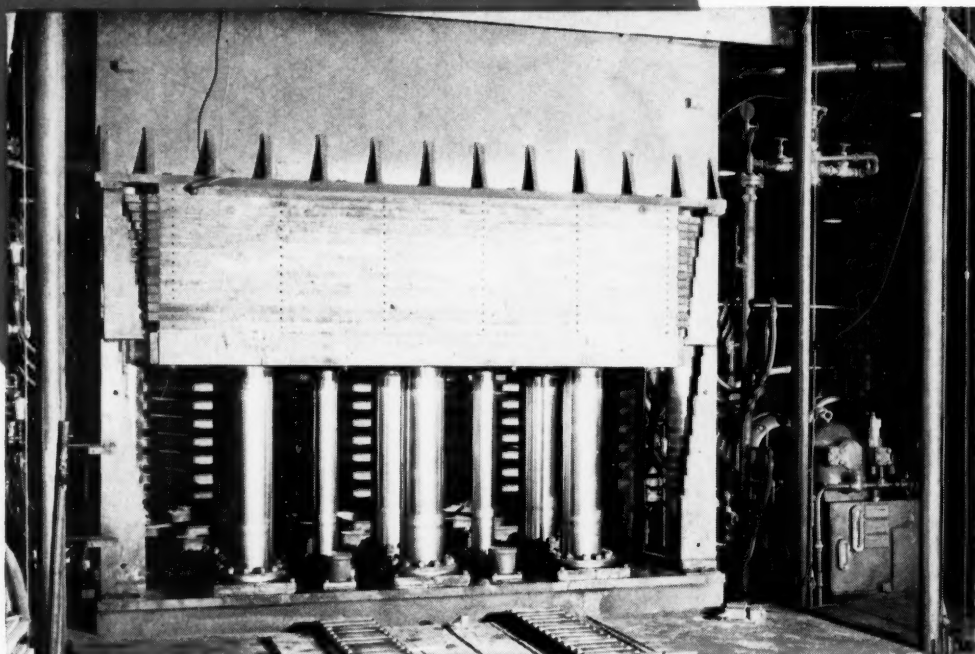
THIS ISSUE

Petroleum Base
Rust
Preventives



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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Petroleum Base Rust Preventives

PROTECTIVE coatings have been used for many hundreds of years in man's battle against the ravages of metal corrosion. Although the early coatings used were inadequate, there was little concern since corrosion was generally accepted as a necessary evil because the mechanism was not clearly understood. The oft-discussed and totally incorrect "phlogiston"¹ theory which was adapted to the explanation of corrosion delayed the progress of chemistry for some time; yet it did valiant service if only to turn the attention of chemists away from the elixir of life and the philosopher's stone to a new field.

Great strides have been made in recent years, both in determining the mechanism of corrosion and the corrective techniques that consequently followed. However, the problem is still the subject of very intensive research and for good reason.

It has been estimated that the annual materials cost of iron and steel rust and corrosion in the United States alone is in excess of six billion dollars — that one of every 50 tons of iron and steel reverts each year to the oxide form — rust.

ON THE THEORY OF RUSTING OF IRON AND STEEL

With the exception of the "noble" metals such as gold, metals occur in nature in an oxidized state and in combinations of metals. Great expenditure of time and money is required to refine these ores to obtain the metals in a useable condition. It is not so strange, therefore, that these refined metals tend to revert again to their natural oxidized state. Whereas the stable noble metals are not subject to such reversion, those of greatest importance to industry and modern civilization, iron and steel, are inherently susceptible. Although there are many conditions that cause and catalyze the corrosion of these ferrous metals, the prime cause, and perhaps most difficult to understand, is that attributable to the presence of *moisture and air*. This phenomenon is technically referred to as electro-chemical attack. Since ordinary water contains free oxygen and air contains various amounts of moisture depending upon humidity conditions, both air and water generally must be excluded from ferrous metal surfaces to avoid electro-chemical attack. Other phenomena contributing to the corrosion of iron and steel are perhaps more readily explained, and the corrective measures necessary to prevent electro-chemical attack are generally applicable to these other forms.

¹The "phlogiston" theory attributed to the seventeenth century alchemists was used conveniently to describe many of the early chemical mysteries. "Phlogiston" was believed to be a component of the elements which weighed less than nothing and the loss of this component from iron on exposure conveniently accounted for the gain in weight as the iron was transformed to rust.

TABLE I
Iron Rust

	<i>Formula</i>	<i>Color</i>	<i>Molecular Weight</i>
Iron Oxide (ous)	FeO	black	71.84
Iron Oxide (ferrosoferric) — magnetite	Fe ₃ O ₄	black-red black	231.52
Iron Oxide (ferrosoferric) — magnetite	Fe ₃ O ₄ (xH ₂ O)	black
Iron Oxide (ic) — hematite	Fe ₂ O ₃	red brown to black	159.68

Electrolytic corrosion traced to the presence of stray electrical currents, chemical corrosion traced to corrosive gases or liquids, and other forms are encountered only under special conditions.

Electro-Chemical Corrosion

It has been said that "the three pre-requisites of an electro-chemical mechanism of corrosion are (1) a potential difference (2) a conductive path and (3) availability of electrode reactions for transferring charges across the metal-solution interface." Such would seem to describe a galvanic cell or common battery, which indeed is just what the electro-chemical mechanism represents. When ordinary water comes in contact with an area of iron or steel, infinite numbers of these galvanic cells are created and the process of rusting has begun. Salt water is even more conducive and acid water still worse. The water provides the electrolyte or the "battery water" for the various cells. The metal itself forms the conductive. The differences in the physical as well as the chemical characteristics of the iron or steel, which are heterogeneous solid solutions, are all that is needed to form the electrodes of the galvanic cells.

TABLE II

Electromotive Force Series of Elements

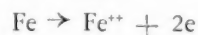
(Listed in order of decreasing tendency to oxidize)

Lithium	Manganese	Antimony
Rubidium	Zinc	Arsenic
Potassium	Chromium	Bismuth
Barium	Iron	Copper
Strontium	Cadmium	Mercury (ous)
Calcium	Cobalt	Silver
Sodium	Nickel	Palladium
Magnesium	Tin	Mercury (ic)
Beryllium	Lead	Platinum
Aluminum	Hydrogen	Gold

For illustration, it would perhaps be convenient to picture the two electrodes that make up each cell as distinctly different metals, as such bi-metal combinations are not uncommon and often lead to very disastrous corrosion. One electrode forms what is known as the anode, the other the cathode of the battery or cell. Ordinary water with its contaminants, which determine the electrolyte's strength, is composed of chemical elements bound together by electrical charges. Water will dissociate into its radicals, as will the contaminating chemicals when in water solution as illustrated using ordinary salt.



There is a potential difference between the electrodes at the instant water touches the metal surface. In an attempt to equalize this potential, the iron at the anode will transform into its ionic state releasing electrical energy.



Equilibrium is never reached, however, as the electrons (negatively charged) released at the anode "flow" to the cathode "where" they combine with the positively charged ions supplied by the dissociation of the electrolyte. The released Fe⁺⁺ ions which are now in electrolyte solution combine with the negative (OH)⁻ ions forming unstable iron hydroxide, which in the presence of air is then transformed to the oxide of iron, rust. The amount of oxygen or air determines the oxide form. In the absence of excess oxygen, the black Fe₃O₄ variety is prevalent, as with steel submerged in water; where an excess of oxygen is available as with steel exposed to the weather, the common red rust Fe₂O₃ is noted. Electro-chemical attack develops and proceeds unimpeded in this manner wherever a galvanic cell exists, i.e. where areas of different electrode potential are in electrical contact with one another as in the presence of water. Unless the condition is corrected, complete conversion to rust is the end result.

It is thus easy to visualize how petroleum base materials can be used so effectively as preservative coatings. In addition to the insulation afforded the metal from air and moisture, they will actually protect the metal surfaces against attack if effective modern chemical inhibitors are incorporated. It further illustrates why good bond of the coating to the metal surfaces to be protected, as well as complete coating, is so important.

In designing any equipment for a given service, special resistant metals or alloys can be used where high resistance to corrosion is necessary or desirable. Other considerations, however, may preclude the use of such materials, and metals subject to rusting, such as iron, plain carbon steels or non-resistant alloy steels may be required. Cost, availability, machineability, strength, and electrical properties are some of these considerations to name a few. It may even be necessary to use dissimilar metals in areas where electro-chemical corrosion can be severe and in such cases, where the use of two or more different metals is necessary, selection of the metals is of extreme importance. Combination of metals differing considerably in electrode potential generally should be avoided. Especially dangerous is the use of a large area cathode metal and a small area anode metal — for example plain steel rivets in a large area monel steel plate. Rapid deterioration of the plain steel components under electrolyte conditions is inevitable. The use of the "galvanic series" representing the related behavior of metals and alloys in natural electrolytes should be referred to wherever the use of bi-metal construction is necessary. In such applications it may be necessary to insulate one metal from the other wherever possible.

TABLE III

Factors Greatly Influencing Corrosion and Rate of Corrosion of Exposed Ferrous Metals

Bi-metal contacts
Crevices at joints, rivets, etc.
Stresses
Wide temperature fluctuations
Temperature differentials between areas
Presence of aeration cells
Environment differentials other than temperature
Hygroscopic surface contaminants
Intermittent drying and wetting
Corrosive gases
Exposure to salt air or water
Stray electrical currents
Bacterial corrosion
Steam or furnace gas
Corrosive chemicals

TABLE IV

Galvanic Series

(Related behavior of metals and alloys in natural electrolytes)

Cathodic (positive)	↑	Stainless steel (passive)	Chromium stainless steel (active)
		Monel metal	Cast Iron
		Silver solder	Wrought Iron
		Nickel (passive)	Mild Steel
		Gunmetal	Cadmium
		Cupro nickel	Aluminum Alloys
		Copper	Aluminum
		Brass	Galvanized wrought iron
		Aluminum bronze	Galvanized steel
		Nickel (active)	Zinc
		Naval bronze	Magnesium alloys
		Manganese bronze	Magnesium
		Tin	
		Lead	
		Stainless steel (active)	
		Lead tin solder	
			↓
			Anodic (negative)

Above table affords a general indication of the couples to be avoided. Especially troublesome would be that of a large area cathodic metal in contact with a small area anodic metal of widely different electrode potential such as monel metal and mild steel.

TABLE V

Factors Influencing the Selection of Preservative Coatings

Degree of protection desired
Environment
Ease of application
Ease of removal
Cost
Special protective characteristics desired, i.e. water displacement, finger print protection, etc.
Condition of surface to be protected
Durability of coating
Location
Appearance
Application equipment available

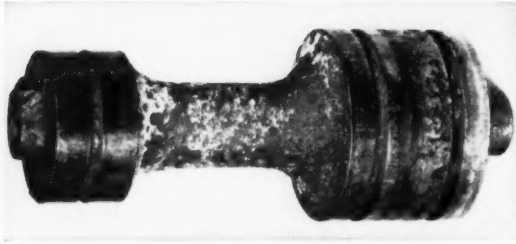


Figure 1 — A badly rusted float control valve spool from a hydraulic system as a result of moisture contaminating the straight mineral hydraulic oil. A rust inhibited hydraulic oil would have prevented this.

The Importance of Protection

In order to maintain our machines in satisfactory operating condition, the slightest corrosion or appearance of rust (iron oxide) must be prevented from forming on the working surfaces. Modern machined parts such as shafting, cylinders, ball and roller bearings, etc., are finished to extreme accuracy and smoothness. The development of rust on these surfaces can easily destroy the value of the machines merely by changing the precise dimensions or by roughening a smooth polished working surface. Rust can occur just as easily on the exterior of equipment if not protected. It is not as destructive, however, to the performance of the machine as interior rusting and can be prevented relatively easily by the use of heavy rust preventive compounds. The prevention of rust on the interior and working surfaces of machines is not only more important but frequently more difficult to accomplish.

With structural components loss of utility occurs gradually and after a period of time, during which the effect of rust is cumulative, the structure becomes useless.

PRESERVATIVE LUBRICANTS

The effects of rust in any lubricating system can be appreciated readily, especially in today's modern high speed equipment where clearances are so close and machined surfaces so very fine — conditions which are so conducive to electro-chemical and electrolytic attack. Conditions are especially bad where salt water (cooling water or condensed salt air) contamination can be expected, as in marine equipment. Water contamination from steam leakage, cooling water leakage, and condensation when units are shut down improperly are quite common. In combustion engines, corrosive gases and moisture originating from combustion are encountered continually. Special lubricants with built in protective characteristics are thus necessary if con-

tinued satisfactory operation is to be realized. Such special lubricants are being used extensively today and protect against rusting while they lubricate.

Turbine and Hydraulic Oil Systems

New castings or freshly machined metal surfaces are most susceptible to rusting. In some instances serious rusting difficulties have been observed after only a few days of operation. Condensation from air entering through leaks, through breathing vents, steam leakage, and cooling water leakage are common difficulties associated with rusting in these systems. In addition to surface damage from rusting, loosened rust particles can cause severe wear or scratch damage to other moving parts, as well as plugging of oil lines to bearings and governor systems. In addition, finely divided rust may act to stabilize emulsions of the oil with water or act as an oxidation catalyst.

Unfortunately, commonly used rust proofing agents or inhibitors are not satisfactory for use with turbine or hydraulic oils, since they adversely affect the various essential characteristics of the oil, i.e. foam resistance, water separating characteristics, oxidation, and sludge resistance. For this reason a very special class of polar inhibitors is required. Inhibitors are now in use which, when added to a straight mineral turbine or hydraulic oil, form a water-resistant film on metal surfaces. Rusting

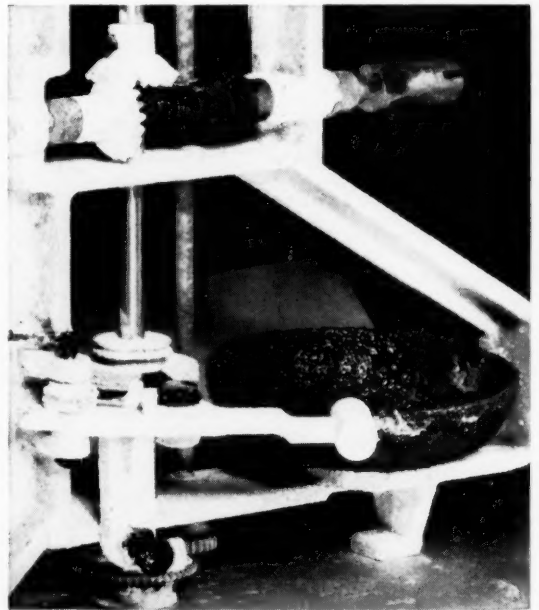


Figure 2 — A mechanical assembly received in the Far East rusted beyond use due to the lack of a rust preventive when packaged.

LUBRICATION

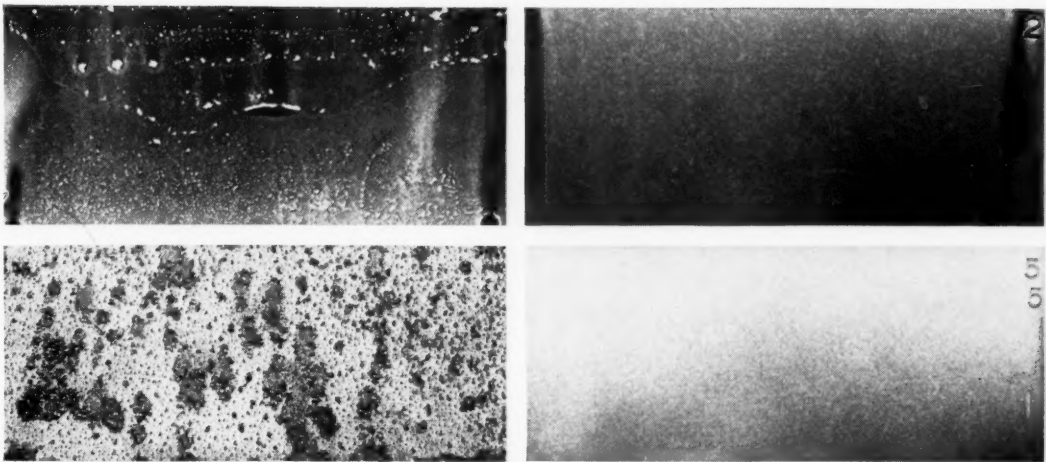


Figure 3 — Flotation type preservatives applied to water-wet test strips.

Strips at left illustrate material with inadequate water-displacing and rust preventive characteristics; upper left after coating and bottom left after exposure for short period in the humidity cabinet test. Strips at right illustrate results of a satisfactory flotation type preservative. Upper right shows test strip after coating with preservative having good water displacement characteristics; lower right illustrates rust-free condition even after several hundred hours in humidity cabinet test.

of these latter is thus prevented, even in the presence of salt water.

Since these special protective lubricants are designed specifically to afford protection under operating conditions and do not afford long-time protection under severe static conditions, other preservative materials are often required during long lay-up periods.

Internal Combustion Engines

Although most modern heavy duty internal combustion lubricants do possess satisfactory rust preventive properties through incorporation of modern additive materials, special protective lubricants are often desirable for the protection of engines to be stored or shipped. New engines after test also require these special engine preservatives, since considerable periods may elapse before they are placed in actual operation. The recommended practice for protecting such engines from corrosion damage is as follows:

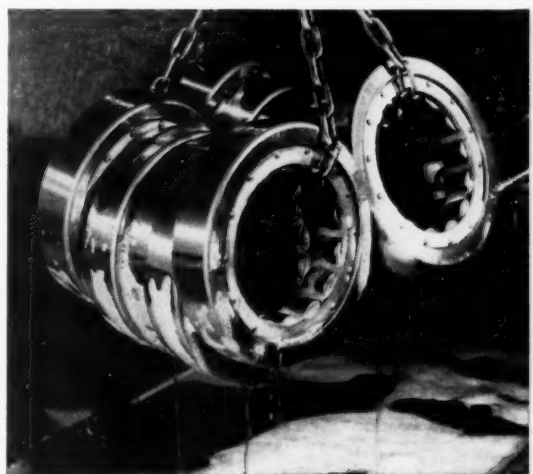
1. Drain used oil from crankcase while engine is still hot and flush with a light flushing oil. Be sure that a clean oil filter cartridge is installed. Refill crankcase with the proper preservative oil, run engine at fast idle for 15 to 20 minutes and shut down. The use of 3% of preservative oil mixed with the fuel for Diesel engines during this run will assist in preventing corrosion of the injectors.

2. Remove spark plugs and spray preservative oil into each cylinder through spark plug hole while engine is being turned over slowly by hand. Dip electrodes and threads of spark plug in preservative oil and replace.

If equipment is available this procedure may be replaced by injecting preservative oil into the intake manifold during the shut-down run. This method is preferred for aircraft engines.

3. Remove distributor cap and coat each lobe of breaker cam with a film of rust preventive compound. Replace cap and seal breather hole in cap with waterproof tape.

4. On valve-in-head engines remove valve cover and spray preservative oil over rocker arm mechanism, interior of valve cover, and between cylinder block and side plate over push rods. Replace cover.



Courtesy of SKF Industries, Inc.

Figure 4 — Dipping large traction motor bearings in hot rust preventive compound.

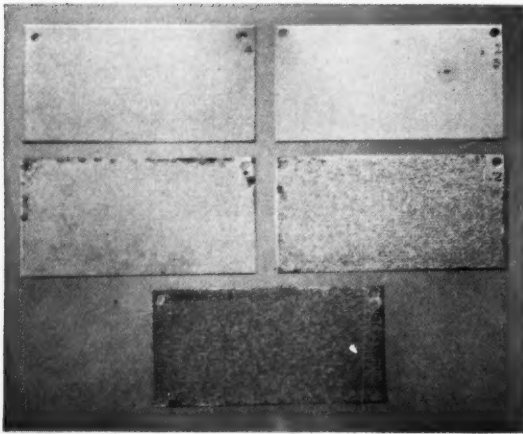


Figure 5 — Humidity cabinet test strips after several hundred hours exposure at 120°F. and 100% relative humidity. Results indicate order of expected performance of the five coatings under service conditions.

5. On gasoline engines drain fuel system including carburetor, fuel pump strainer, lines and tank. Close all openings and re-connect all fittings. Apply rust preventive compound to all linkage, pins, choke, and throttle rods.

6. Be careful not to get oil or grease on rubber connections or parts, as serious deterioration may result.

7. When placing engines in service after storage, all rust preventive compound should be removed with kerosine or other suitable solvent.

8. It is not necessary to drain the preservative from non-aircraft engines until the expiration of the normal drain period. For aircraft engines, it is desirable to drain, flush and install fresh change of the proper lubricating oil for operation.

Grease Lubricated Components

Although the selection of a grease should be based primarily upon the lubrication requirements, there are certain applications where the rust protecting properties deserve much consideration. Many grades and types of greases are now available which have rust inhibiting properties not possessed by ordinary grease. The type of soap base is also important in making this selection. A soda soap base grease for example, as well as some lithium base greases, offers the advantage of picking up the moisture and "locking it in" to prevent it from reaching the susceptible metal parts.

Packaging, Storage and Shipment of grease lubricated parts

Although special preservative oils and compounds are generally used for long time protection,

it is often desirable and convenient to pack grease lubricated parts with the grease to be used in service. Ball and roller bearings for example, if to be placed in storage or packaged for shipment, are often previously over-packed with the grease to be used in service and then wrapped with special preservative paper before packaging. Prior to use, the excess grease is removed. Such procedure avoids excess handling of the bare metal which is so susceptible to attack from moisture cleaning chemicals, fingerprints during high humidity conditions, etc. The ready availability of greases with incorporated inhibitors makes such a practice very feasible.

Each such application requires special consideration, however, and no general guide for selection of such greases can be made.

Open Gear Lubrication

Open gears are often required to perform under excessively wet conditions, and modified open gear lubricants are available to give the user all the benefits of the regular lubricants under water conditions.

For Wire Ropes and Cables

Wire rope is often subjected to conditions approaching the abnormal. As an example, in the mining industry, the rope soon wears out unless it is properly safeguarded. Its contact with mine water causes rapid corrosion. The continuous strains and stresses due to rapid winding and unwinding, with the attending cutting action of the wires, necessitate proper protection both internally and externally, if



Figure 6 — Mild steel test strip 19 seconds after several drops of a mild salt solution containing a small amount of potassium ferri-cyanide indicator was applied. Attack is immediate and where ferrous ions go into solution (rusting) they react with the indicator to form an iron salt giving the prussian blue coloration. The blue denotes the rusting action at the anodic areas and the colorless patches represent the cathodic areas.

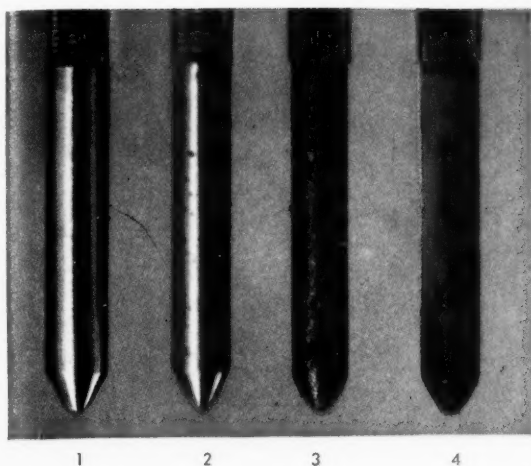


Figure 7 — ASTM D665-54 Turbine Oil Rusting Test specimens showing results obtained using (1) a satisfactory inhibited turbine oil run with salt water, (2) an unsatisfactory inhibited turbine oil run with salt water, (3) a straight mineral oil run with distilled water and (4) a straight mineral oil run with salt water.

the rope is to give the desired length of service. Considerably increased life can be gained by using a protective lubricant instead of an ordinary lubricant.

PRESERVATIVE COATINGS (non-lubricating)

Of the many materials being offered today as preservative coatings, those of petroleum base are by far the most widely used. They are designed specifically to form a protective barrier on the metal surface against a corrosive environment and through the use of special chemicals to actually inhibit the metal surfaces against attack.

The majority of preservative coatings are designed to give best results when applied to clean dry surfaces. However, application under adverse conditions is often necessary and must be accounted for. For this reason a wide variety of petroleum base preservatives have been developed for a wide variety of applications, and an understanding of the exact conditions under which protection is desired is necessary to make the proper selection of preservative material.

Oily Film Coatings (for easy application and removal)

Protective oils and fluids fall in this category. They are generally of low viscosity and form non-drying oil films to afford temporary protection under relatively mild corrosive conditions. Although straight mineral oils do afford some degree

of protection and are used extensively in some protective applications, their use is limited to short period protection to rough surfaces under very mild conditions. For temporary protection, even under inside conditions for machined surfaces, oils or fluids (solvent diluted oils) containing anti-rust additives are necessary. Fluids are generally desired to afford ease of application and yet leave an oily film of desired thickness and viscosity after the solvent evaporates. The fluidity also lends itself to easy additive incorporation. Oily film coatings can be applied by dip, spray, swab or brush. They are designed specifically for the protection of sheet steel, hand tools, small parts, bearings, and any highly machined surfaces under relatively mild conditions of storage, packaged shipment, or inter-process protection. They are often required to protect parts wet with water or soluble oil from machining operations, as well as parts handled by hand during high humidity conditions. For such applications, special *water displacing and fingerprint removal-suppression characteristics* are also mandatory.

Where necessary, these oily films are readily removed by wiping, solvent washing, or hot water washing. Such removal is necessary where parts are to be further processed or "plated."

For sheet steel, fluids of approximately 100 seconds saybolt viscosity at 100°F. which will afford protection in acid atmospheres are often desired. Fluids of this viscosity give desired protection, prevent scratching of the sheets, and prevent "tele-scoping" of the stacks.

Where protection for long periods of storage under more severe conditions is desired, the "soft film" type coatings are generally required.



Figure 8 — Circular saw after packaged storage with corrosion from finger prints plainly in evidence. The use of a protective coating with perspiration neutralizers incorporated would eliminate this.

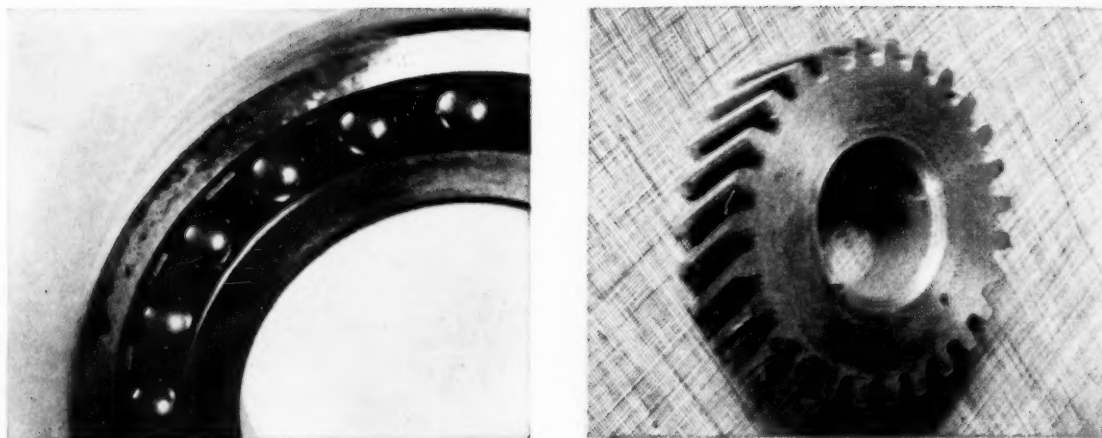


Figure 9 — Corrosion attributable to contamination of the lubricant with water. The use of lubricants with rust-protecting properties would eliminate these difficulties.

Soft Film Coatings

Petroleum base preventives of the soft film compound type give more sustained protection than the oily film or the hard film variety. The protection, however, depends on the thickness and consistency of the film obtained as the barrier, as well as the effectiveness and types of inhibitors employed. They may range from very thin transparent films for the protection of small parts under relatively mild conditions to heavy thick wax-like coatings for the protection of structures, heavy equipment, etc., under severe conditions. Such materials must be fluid at the time of application. Some require heating to obtain the necessary fluidity; others are available in solvent solution, the solvent evaporating after application, leaving the protective film.

Application may be by brush or trowel in the case of the heavier more viscous forms; brush, spray dip or swab in the solvent cut-back form; and by dip operation employing the hot-dip variety.

Heavy film coatings are suitable for protection of equipment, structures, or parts in corrosive atmospheres (under exposure to salt air, salt water, etc.). They afford long time protection in all kinds of weather and also protect under submerged conditions.

It is of utmost importance to realize that where possible not only the most susceptible metal areas should be protected by a preservative coating but the resistant metal areas should also be covered, at least where they are in close proximity in bi-metal construction. A break in the protective film on the non-resistant surfaces will produce a very concentrated attack in the presence of an electrolyte, i.e. the case of a large cathode and a small area anode.

Many fields of applications have found the soft film variety the answer to the rusting and corrosion problems: Marine, Railroad, Farm, Sewage disposal, Industrial, Automotive, Contractors and Road Building Equipment, Machine Tools of all types, and Aircraft.

Although best results are obtained with application to dry clean surfaces, some materials are designed specifically to afford protection when applied to wet or badly rusted surfaces.

Soft film compounds are used extensively for the protection of small parts in storage or shipment. The hot-dip variety is most generally employed where parts to be protected are of a size to be conveniently handled for dipping into tanks containing the heated material. The temperature of the bath, the number of dippings, and the duration of dip will determine the thickness of coating obtained. Where removal of the coating is necessary, it may be accomplished by wiping with a kerosine soaked cloth or solvent washing.

Although these coatings may have self-sealing properties, the use of hard film coatings is recommended for applications where repeated abrasions of the surface is anticipated.

Hard Film Coatings

Fluids forming hard solvent-deposited coatings of bitumen, alone or with asbestos fillers, are in general use as inexpensive coatings for applications subject to abrasion, such as deck coatings, guard rails, etc. The nature of the material is such that application must be made in relatively thin films to clean dry surfaces to insure good adherence and prevent cracking and chipping of the coating. The film provided is not self sealing and a break in the

surface coating can lead to severe general under-surface attack. Where necessary, thinning with painter's naphtha is allowable to give easier application and correspondingly thinner coats. Although removal is somewhat more difficult than with the soft film coatings, the use of a thinner will soften the coating and effect removal.

Flotation Type (Marine)

Although solvent cut-back soft film compounds have been used quite satisfactorily when applied by brush or spray application for the protection of marine ballast tanks, voids, cofferdams, etc., the cost of application is high and in some cases prohibitive. For this reason, protective petroleum base fluids have been developed for application by flotation methods. The preservative material is placed in the enclosure to be protected and is applied by raising and lowering the water level. By this means the cost of application is materially reduced.

The nature of the application requires such flotation type products to have efficient water displacing, rust penetrating, and adhesive qualities to afford long time protection.

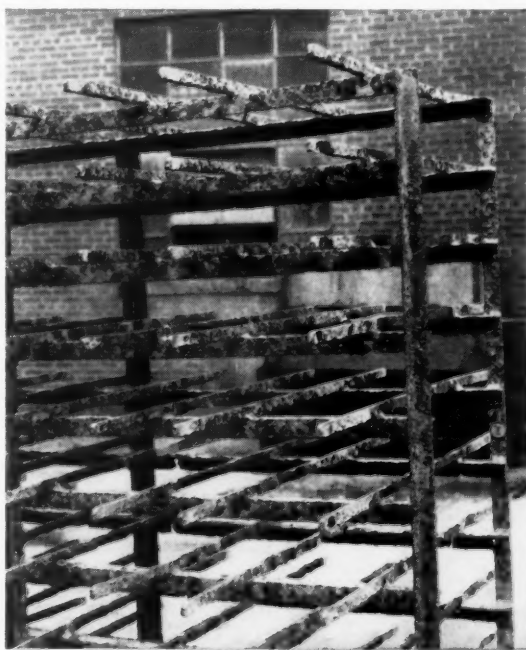
Soluble Oil Types

Under excessively wet conditions, the use of

soluble oils are often employed to afford rust protection from the water. Their ability to emulsify with water easily, preventing free water contact with metal surfaces, affords some degree of protection. Conditions leading to the breakdown of such emulsions under long time storage, however, would result in the formation of free water and rusting.

SURFACE PREPARATION PRIOR TO APPLICATION OF PETROLEUM BASE RUST PREVENTATIVES

Although large structural members, finished machinery, tanks, decks, etc., require little, if any, surface preparation, metal stock and newly finished pieces are generally far from clean and are in unsatisfactory condition for protective applications where best results are expected. The contaminants to be removed include dust, dirt, moisture, perspiration residue, metal chips, cutting, cooling, drawing, and polishing compounds, rust and scale, welding or soldering fluxes, chemical mists, residues from heat treating processes, pickling acids, and etching solutions. Where moisture or perspiration residues are the only contaminants encountered with a particular part, protectives with water displacing and perspiration neutralizing properties can be used to clean effectively and protect in a single application.



Courtesy of Riverside Dunbrik Co.

Figure 10 — Steel racks used in concrete block industry with (left) and without (right) the protection of a soft film preservative.

Protectives without such properties should be applied only after the surfaces are properly cleaned. The following cleaning methods are most generally employed for obtaining a satisfactory surface prior to application of the preservatives:

Mechanical Cleaning

Where the surfaces are already rusted or covered with scale or dirt, mechanical cleaning is often carried out by scraping, using a wire brush or steel wool, or blasting with shot or sand. In many cases, this is sufficient, particularly if surfaces are dry. This procedure, of course, is not considered for highly machined surfaces.

Chemical Cleaning

Immersion in a hot mild alkali bath up to 200°F., followed by a thorough clean hot water wash, is effective in removing most types of surface dirt and contamination. Such a procedure includes the use of many chemicals such as alkali silicates, phosphates, borates, and carbonates. In many cases, synthetic wetting agents and soaps are added to give improved cleaning. Unless the rinsing is thorough and properly carried out, the residue remaining from the cleaner itself tends to cause slight rusting. This method is not recommended for highly polished steel surfaces, nor for use with aluminum, zinc, or magnesium components.

Metal surfaces of finished equipment with slight deposits of rust may normally be cleaned effectively by application of a rust remover such as the

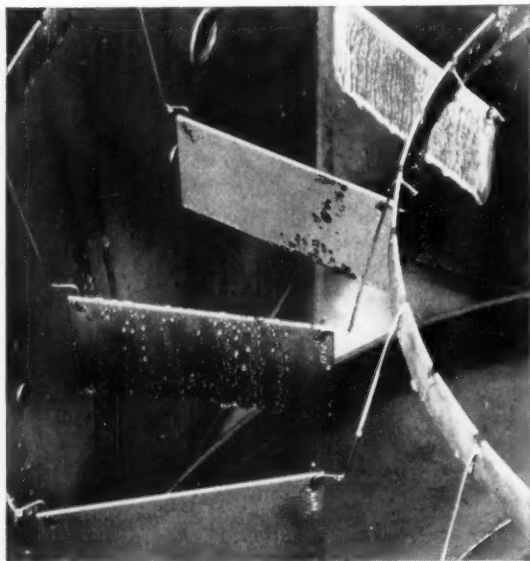


Figure 11 — Humidity Cabinet test apparatus with cover removed. Note high humidity conditions with moisture condensing in droplets on test specimens.



Figure 12 — Swabbing a protective coating on bridge deck to protect from brine drip, sewage, locomotive blow-off and scuffing.

phosphoric acid type. Here again, complete rinsing of the treated surfaces are required after application of the cleaner and prior to the application of the preservative.

Solvent Cleaning

Solvents are used extensively for cleaning, particularly for oil, grease, moisture, and perspiration residues. Petroleum solvents, either stoddard solvent or dry cleaners, are effective oil and grease removers. Alcohols are generally required to effect removal of moisture and perspiration residues. Where vapor degreasing techniques are used, selected fire resistant solvents are recommended. With the latter, objects to be cleaned are suspended in a specially designed tank in a vapor of the solvent which condenses on the parts and then runs off, carrying the dissolved contaminants with it. In this process, it is important that the degreasing solvents be kept water-free and checked regularly for the presence of free acids, since either can cause corrosion of the material being cleaned.

Miscellaneous Cleaning

Steam cleaning is effective both for impact removal of contaminants and also for the effective solvent action on many such substances. Hot water rinsing is also often employed, although thorough drying is essential before preservative application. Heat treatment salt residues and fluxes are best removed by such methods employing steam or water.

It should be realized that freshly cleaned materials are especially vulnerable to corrosive attack,



Figure 13 — Spray application of a soft film preservative to sedimentation tank.

and the protective should be applied immediately after the cleaning operation is completed.

APPLICATION OF PREVENTATIVES

The choice of the method of application is governed by the nature of the protective to be employed, the equipment available, and the size and design of the item to be protected. Although dipping is preferable since it is quick and produces an even coating, it may be unsuitable for items with non-metallic components or for those of large size or which are already assembled.

Dipping

This procedure is generally used on smaller items which can be handled conveniently without requiring too large a dipping tank. There have been instances, however, where it was found expedient to dip large equipment packed in open crates up to thirty feet long as a single unit.

Rustproof oils and fluids as well as solvent cut-back compounds may be applied by dipping at room temperature. Hot dip compounds require heating and afford a heavier protective coating than the oils, fluids or solvent cut-back compounds. Solvents such as stoddard solvent or kerosine are normally employed for thinning, and loss of the solvent through evaporation yields the base material coating.

The size of the tank required depends on the size of the items to be dipped and should be sufficiently large to prevent excessive cooling of the preservative when the items are dipped. The tank should be equipped with a cover to prevent excessive ingress of contaminants and loss of solvent where

such is employed. It should be designed with a sloping false bottom to allow for easy removal of contaminants and to prevent contact of items with accumulated contaminants. Frequent run-off of contaminants is desirable especially where water displacement preservatives are employed.

Loss of solvent from the bath when employed will result in a gradual thickening of the preservative and it may be necessary to replenish lost solvent to maintain the desirable coating characteristics. Adequate ventilation is a must!

Hot-dip materials should be heated either by a steam jacketed source or by use of electric heaters in preference to open firing. The latter may give rise to hot spots and result in charring of the preservative. Open firing is never employed where solvent cut-back preservatives are used. The temperature of hot-dip compounds is generally held at 20-40°F. above the melting point, which would mean a bath temperature of 140-200°F.

The duration of dip will depend on the thickness of coating desired, the type of preservative employed, as well as the size and condition of the items being treated. With hot-dip materials there are two means of controlling the thickness of the coating for a single application, i.e., temperature of bath and duration of the dip. Raising the temperature of the preservative will cause it to run off more readily, thus reducing the thickness of coating. Likewise, leaving the item submerged for a longer period will raise the surface temperature of the item and thereby facilitate the draining of the preservative with resultant reduction in film



Courtesy of SKF Industries, Inc.

Figure 14—Corrosion of outer bearing race caused by moisture trapped under slushing compound.

thickness. A typical example demonstrating these effects is shown below:

<i>Temperature of Bath °F.</i>	<i>Film Thickness, Inches</i>	
	<i>One Second Immersion</i>	<i>Thirty Seconds Immersion</i>
150	0.039	0.007
175	0.019	0.005
200	0.018	0.004
250	0.018	0.003

Where heavier coatings are desired, repeated dippings will build up the thickness. Large items warm up more slowly than smaller items; therefore, for a given dipping time, heavier coatings would be obtained with the former. With materials for displacing water and neutralizing perspiration, longer periods of dipping are required to insure of complete water and salts removal.

Spraying

Where it is not practical to apply preservatives by dipping, spray application is the next preferable choice. Oils, fluids, and compounds (either solvent cut-back or heated) of the soft-film or hard film variety are suitable for spray application. This application is particularly adaptable for heavy structures.

A variety of spray equipment is available for use with these materials. The air pressure supply to the preservative tank should be controlled independently. A ten-gallon preservative tank with 40 lbs. per square inch air supply and a 60 lbs. per square inch air supply for the gun is normally satisfactory, although an available air supply of at least 100 lbs. per square inch is desirable.

Preservatives should be poured through strainers when filling the tanks, in order to remove contaminants and prevent plugging of the spray gun. The spray should be adjusted to furnish good atomization without slugging. Since solvent will evaporate from the spray nozzle when not in use, the nozzle should be cleaned after each use.

Normally, spraying should be done only in open or in well ventilated spray booths to prevent excessive concentrations of the solvent. If it is necessary to spray in a confined area, adequate ventilation should be provided.

Brush Application

Brush application is often employed where a heavy protective coating is desired and where the surface condition is sufficiently rusty to necessitate "working the coating in" to the metals. For such applications, thixotropic preservatives which are solid but easily worked at room temperatures are usually employed. Solvent cut-back coatings can also be applied in this way but they furnish a thinner coating. The heavier coatings are particularly desirable for outdoor structures for long time protection under severe conditions.

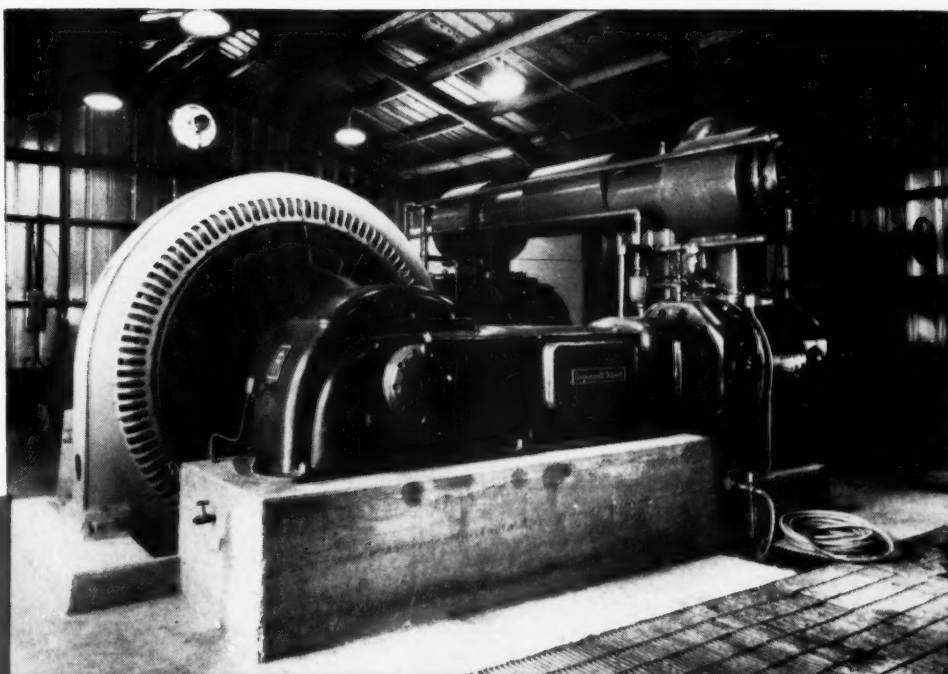
Flotation

For the internal protection of marine ballast tanks, voids, coffer dams (compartments), or similar equipment where the cost of hand application and staging is prohibitive, special preservatives are available for application by flotation means. Such materials are floated on top of water and coating is obtained by alternately raising and lowering the water level. The nature of the application is such that materials so used must not emulsify with the water, possess good water displacement and rust penetrating properties, and provide good protection to surfaces under wet conditions.

No surface preparation is required, and the amount of preservative to be used will vary with the porosity of the surface, as well as the size and shape of the compartment to be coated. Since penetration through rust is one feature of such coatings, considerable rust may drop off after application of the preservative to badly rusted areas. If the preservative flotative layer is maintained in the compartment, effective protection can be realized by re-floating the preservative to cover these exposed areas; otherwise, a second application is recommended.

CONCLUSION

The cost of preventive maintenance is infinitely small compared to the costs incurred in replacing or reprocessing useful materials rendered useless in short periods by nature's process. A wide variety of petroleum lubricants and petroleum base preservatives specifically designed to prevent rust and corrosion are available to fit the variety of needs existing. Rust and corrosion are no longer necessary evils and the intelligent use of protectives can materially reduce the excessive costs incurred through the lack of suitable preventive maintenance.



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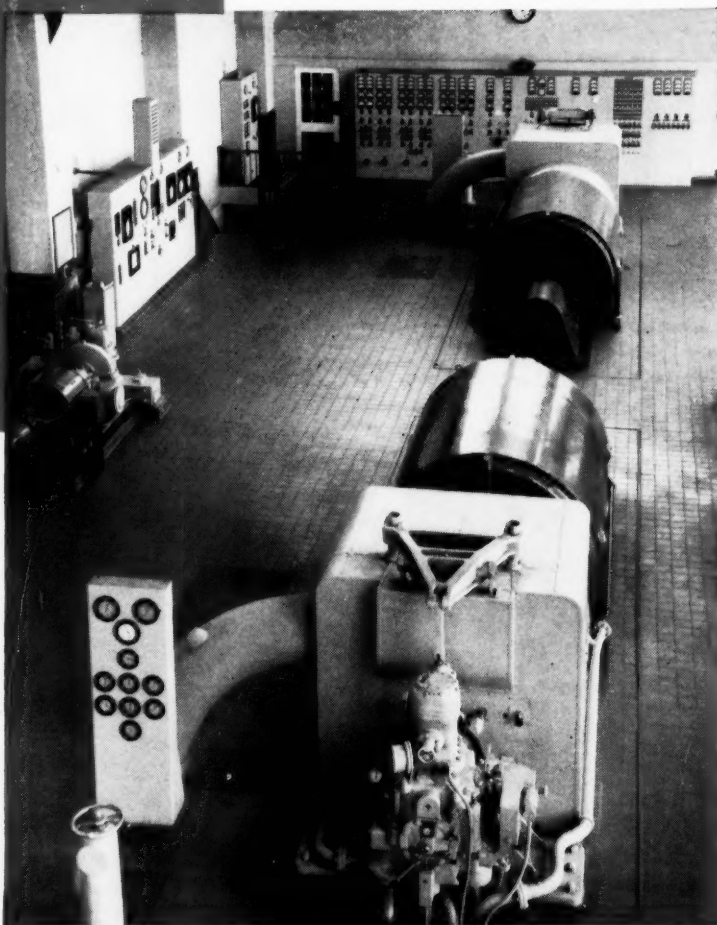
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